Ohio Agricultural Experiment Station

CIRCULAR No. 104.

WOOSTER, OHIO, AUGUST 15, 1910

PLANS AND SUMMARY TABLES

OF THE EXPERIMENTS AT THE CENTRAL FARM, WOOSTER,

ON THE

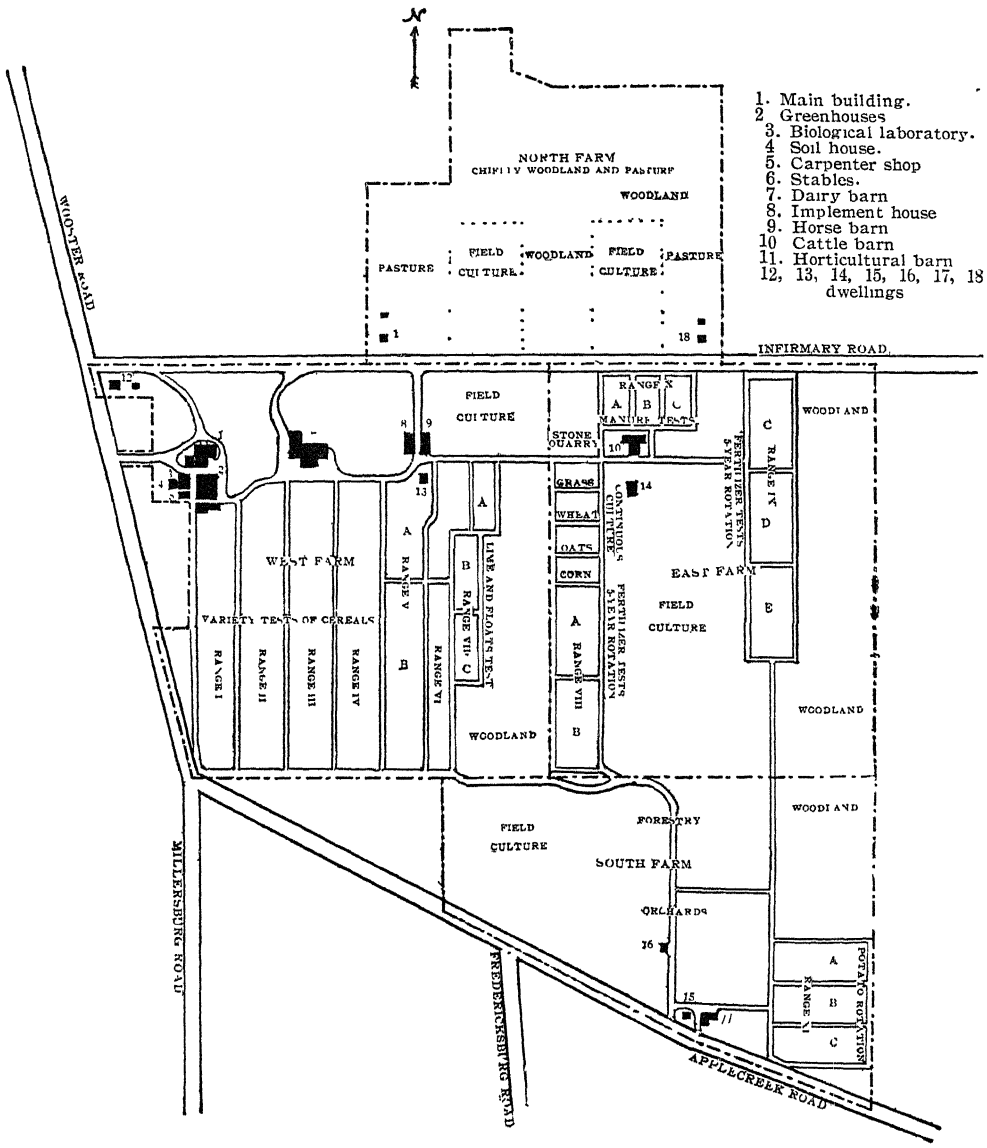
MAINTENANCE OF SOIL FERTILITY.

ARRANGED FOR REFERENCE IN THE FIELD.

ANNOUNCEMENT

The experiments reported in the following pages were begun in 1893, immediately after the removal of the Experiment Station to Wayne county. The general plan of this work and the results obtained up to that time are published in Bulletin 110, issued in December, 1899, (now out of print) and again in Bulletins 182, 183, and 184, reporting to the end of 1906. It now seems desirable to follow these general publications with an annual statement, giving as briefly as possible the new data obtained from each successive crop, and referring the reader to Bulletins 182 and 183 for more complete information respecting the nature of the soils under experiment and the general plan of the work.

The results for 1907 are given in Circular No. 83, and those for 1908 in Circular No. 92.



The central farm, near Wooster.

FERTILIZERS AND MANURE ON CROPS GROWN CONTINUOUSLY ON THE SAME LAND.

Wheat, oats and corn, one acre (10 plots) each, have been grown in this experiment since 1894. The fertilizers are applied to Plots 2 and 8 in arbitrary quantities, while on Plots 3 and 9 the three fertilizing elements, nitrogen, phosphorus and potassium, are given in approximately the same ratio to each other in which they are found in the plant.

The applications to Plots 2 and 8 have in every case produced larger yields than those to Plots 3 and 9, but this may in part be accounted for by the combined nitrogen which is carried to the soil in rain, thus enabling the crops grown on 2 and 8 to utilize larger quantities of the phosphorus and potassium given in the fertilizer than merely that required to balance the fertilizer nitrogen.

The manure applications on plots 5 and 6 were intended to carry nitrogen in quantities equivalent to the applications on Plots 2 and 3 on the one hand and 8 and 9 on the other, estimating the manure to carry 10 pounds of nitrogen per ton, but actual analyses of manure, made during recent years, indicate that this estimate was too high for open yard manure, such as is used in these tests. The average application of phosphorus and potassium in the manure closely approximates the average given to the four fertilized plots.

In this test the corn and wheat show a rapid falling off in yield on the unfertilized land during recent years. The oats also show a reduction in yield, but not so great as that of the other crops.

It is much more difficult to control the weed growth in the wheat and oats grown continuously than where the same crops are grown in rotation, and it has been necessary to divide these tracts and fallow the two ends in alternate seasons in order to destroy the weeds.

Diagram I shows the arrangement of plots and plan of fertilizing in this experiment, and the general outcome is shown in Table I, which gives the yields by periods.

DIAGRAM I: PLAN OF FERTILIZING IN CONTINUOUS CULTURE

PLOTS ONE-TENTH ACRE

	Fertilizing materials in pounds per acre
Wheat	1 None.
	2 Acid phos., 160; muriate potash, 100; nitrate soda, 160.
	3 Acid phos., 60; muriate potash, 30; nitrate soda, 160.
	4 None.
	5 Yard manure, 2½ tons.
	6 Yard manure, 5 tons.
	7 None.
	8 Acid phos., 160; muriate potash, 100; nitrate of soda, 320.
	9 Acid phos., 120; muriate potash, 60; nitrate of soda, 320.
	10 None.
Oats	1 None.
	2 Acid phos., 160; muriate potash, 100; nitrate soda, 160.
	3 Acid phos., 55; muriate potash, 50; nitrate soda, 160.
	4 None.
	5 Yard manure, 2½ tons.
	6 Yard manure, 5 tons.
	7 None.
	8 Acid phos., 160; muriate potash, 100; nitrate soda, 320.
	9 Acid phos., 110 muriate potash, 100; nitrate soda, 320.
	10 None.
Corn	1 None.
	2 Acid phos., 160; muriate potash, 100; nitrate soda, 160.
	3 Acid phos., 45; muriate potash, 30; nitrate soda, 160.
	4 None.
	5 Yard manure, 2½ tons.
	6 Yard manure, 5 tons.
	7 None.
	8 Acid phos. 160; muriate potash, 100; nitrate soda, 320.
	9 Acid phos., 90; muriate potash, 60; nitrate soda, 320.
	10 None.

(South)

TABLE I: CROPS GROWN IN CONTINUOUS CULTURE. Yield and increase per acre for 1909 and average annual yield for 16 years 1894 to 1909

Plot No.	Fertilizing materials Pounds per acre	1909 Yield Grain Bus.	1909 Yield Stover or straw Lbs.	1909 Increase Grain Bus.	1909 Increase Stover or straw Lbs.	16 years, 1894 to 1909 Yield Grain Bus.	16 years, 1894 to 1909 Yield Stover or straw Lbs.	16 years, 1894 to 1909 Increase Grain Bus.	16 years, 1894 to 1909 Increase Stover or straw Lbs.	Plot No.
	Corn									
1	None	14.90	1,910	.....	.....	22.22	1,441	.....	.....	1
2	Acid phosphate, 160; muriate potash, 100; nitrate soda, 160	31.79	3,220	20.00	1,463	42.71	2,326	22.08	949	2
3	" " 60; " " 30; " " 160	29.43	2,500	20.75	897	34.95	1,946	15.90	634	3
4	None	5.57	1,450	.....	.....	17.46	1,248	.....	.....	4
5	Yard manure, 2½ tons	15.68	2,100	9.79	730	28.92	1,761	11.92	529	5
6	" " 5 "	25.86	2,650	19.64	1,360	38.45	2,124	21.90	909	6
7	None	6.54	1,210	.....	.....	16.07	1,199	.....	.....	7
8	Acid phosphate, 160; muriate potash, 100; nitrate soda, 320	52.50	3,260	46.53	2,013	47.51	2,376	32.45	1,226	8
9	" " 120; " " 60; " " 320	49.21	3,140	43.82	1,857	45.15	2,246	31.10	1,146	9
10	None	4.82	1,320	.....	.....	13.03	1,051	.....	.....	10
	Average unfertilized yield	7.96	1 473	....	.....	18.15	1 252		.....	
	Oats									
1	None	16.72	895	.....	.....	21 05	783	.....	.....	1
2	Acid phosphate, 160; muriate potash, 100; nitrate soda, 160	38.44	2,370	21.49	1,482	42.34	1,877	20.64	1,065	2
3	" " 55; " " 50; " " 160	36.72	2,155	19.53	1,275	38.55	1,642	16.20	801	3
4	None	17.42	873	.....	.....	23.00	871	.....	.....	4
5	Yard manure, 2½ tons	26.88	1,440	9.28	533	31.17	1,220	7.93	314	5
6	" " 5 "	36.64	2,228	18.85	1,287	38.44	1,706	14.97	765	6
7	None	17.97	975	.....	.....	23.72	977	.....	.....	7
8	Acid phosphate, 160; muriate potash, 100; nitrate soda, 320	46.57	3,180	28.05	2,139	48.38	2,419	24.27	1,439	8
9	" " 110; " " 100; " " 320	45.55	3.093	26.49	1,986	46.57	2,275	22.08	1,293	9
10	None	19.61	1,173	.....	.....	24.88	985	.....	.....	10
	Average unfertilized yield	17.93	979	....	.....	23.44	909	.....	.....	
	Wheat									
1	None	10.01	1,178	.....	.....	8 24	1,104	.....	.....	1
2	Acid phos., 160; mur. potash, 100; nit. soda, 120; dried blood, 50	27.25	3,829	17.05	2,637	20.17	2 529	11.77	1,460	2
3	" " 45; " " 30; " " 120; " " 50	23.65	2,726	13.25	1,521	16.02	1,896	7.47	861	3
4	None	10.59	1,219	.....	.....	8.70	1,000	.....	.....	4
5	Yard manure, 2½ tons	22.49	2,554	11.98	1,319	13.83	1,705	5.17	696	5
6	" " 5 "	28.24	3,159	17.80	1,909	17.93	2,206	9.30	1,188	6
7	None	10.36	1,266	.....	.....	8.60	1,027	.....	.....	7
8	Acid phos., 160; mur. potash, 100; nit. soda, 200; dried blood, 50	31.77	4,546	22.42	3,440	22.87	2,922	14.57	1,938	8
9	" " 90; " " 60; " " 200; " " 50	30.19	3,919	21.84	2,974	20.82	2,491	12.82	1,550	9
10	None	7.34	785	. .	.....	7.70	897	. . .	. . .	10
	Average unfertilized yield	9.58	1,112		.	8.31	1,007	.	.	

TABLE II: CROPS GROWN IN CONTINUOUS CULTURE. Average annual yield and increase per acre by 5-year periods

Plot No.	Grain						Stover or straw						Plot No.
	1894-1898		1899-1903		1904-1908		1894-1898		1899-1903		1904-1908		
	Yield Bus.	Increase Bus.	Yield Bus.	Increase Bus.	Yield Bus.	Increase Bus.	Yield Lbs.	Increase Lbs.	Yield Lbs.	Increase Lbs.	Yield Lbs.	Increase Lbs.	
Corn													
1	29.19	.....	21.85	.....	17.09	.....	1,449	.....	1,234	.....	1,546	.....	1
2	44.61	15.53	47.21	27.03	38.50	24.08	2,076	630	2,202	1.013	2,520	1,394	2
3	38.86	9.88	39.09	20.59	28.00	16.25	1,770	330	1,820	671	2,138	848	3
4	28.86	.....	16.81	.....	9.09	.....	1,436	.....	1,106	.....	1,162	.....	4
5	36.44	8.68	29.21	12.75	23.77	14.75	1,670	278	1,588	497	1,958	773	5
6	43.13	16.49	40.11	24.01	34 62	25.65	1,938	590	1,924	851	2,404	1,195	6
7	25.53	.....	15.74	.....	8.86	.....	1,304	.....	1,060	.....	1,232	.....	7
8	44.43	20.26	52.55	37.85	44.55	36.41	2,008	749	2,376	1,358	2,568	1,415	8
9	42.76	19.96	50.13	36.45	41.73	34.34	1,870	655	2,232	1,256	2,458	1,383	9
10	21.44	.....	12.65	.....	6.64	.....	1,170	.....	934	.....	996	.....	10
	26.26	.....	16.76	.....	10.43	.....	1,339	.....	1,083	.....	1 231	.....	
Oats													
1	26.87	.....	16.75	.....	20.40	.....	892	.....	578	.....	855	.....	1
2	42.22	14.75	40.11	22.39	45.46	24.59	1,697	749	1,701	1,083	2,136	1,279	2
3	38.75	10.67	36.47	17.78	40.79	19.46	1,470	467	1 463	806	1,890	1,037	3
4	28.67	.....	19.66	.....	21.80	.....	1,059	....	697	.....	855	.....	4
5	30.83	2.40	28.51	8.13	35.03	12.98	1,021	—55	1,030	283	1,565	670	5
6	34.81	6.63	36.76	15.67	44.10	21.83	1,265	173	1,516	720	2,232	1,297	6
7	27.94	.....	21.82	.....	22.55	.....	1,110	.....	846	.....	974	.....	7
8	48.75	20.37	48.87	26.51	47.89	25.17	2,086	971	2,342	1,493	2,675	1,712	8
9	46.94	18 10	47.36	24.46	45.61	22.80	1,982	862	2 131	1,078	2,548	1,601	9
10	29 28	.....	23.43	.....	22.98	.....	1,125	.....	856	.....	936	.....	10
	28.19	.....	20.41	. ...	21.93	.....	1,046	. ..	744	.....	905	.....	
Wheat													
1	10.56	.....	7.86	.....	5.95	.....	1,334	.....	926	.....	1,038	.....	1
2	19.78	9.32	21.90	13.73	17.41	11.21	2,205	967	2,420	1,489	2,701	1,684	2
3	16.33	5.97	16.90	8.42	13.31	6.87	1,720	579	1,644	709	2,158	1,163	3
4	10.26	.....	8.78	.....	6.68	....	1,044	.....	940	....	973	.....	4
5	13.28	3.13	14.26	5.28	12.23	5.74	1,475	430	1,498	550	1,973	982	5
6	15.77	5.72	18.46	9.28	17.48	11.18	1,743	698	2,014	1,057	2,670	1,663	6
7	9.95	....	9.38	.....	6.11	....	1,045	.....	965	.....	1,025	.....	7
8	20.69	10.87	25.26	16.47	20.88	14.80	2,510	1,463	2,724	1,810	3,208	2,239	8
9	19.01	9.33	22.45	14.25	19.12	13.10	2,159	1,110	2,181	1,323	2,846	1,933	9
10	9.55	.....	7.62	.....	6.00	.....	1,051	.....	805	.....	858	.....	10
	10.08	.....	8.41	.....	6.19	.....	1 119	.....	909	.....	973	.....	

THE 5-YEAR ROTATION

In this experiment corn, oats, wheat, clover and timothy are grown in succession on five tracts of land, A, B, C, D and E, containing 30 one-tenth acre plots each. Sections A and B of this test lie in range VIII, south of the areas devoted to continuous cropping, while sections C, D and E occupy Range IX, near the east side of the farm.

The land was underdrained in 1893, and corn was grown that season on section C. The planting was delayed by the draining and the season proved unfavorable, so that the results of that season's work have not been included in the average. In 1894 wheat was harvested on section A, oats on section C and corn on section D. The clover and timothy followed the wheat on section A in 1895 and 1896, and the rotation has since been regularly followed.

Beginning with 1900, lime was applied to the west half of each plot in this rotation, fertilized and unfertilized alike, while the land was being prepared for corn, the lime being applied at the rate of one ton per acre of ground quicklime in 1900, 1901, 1902 and 1903, applied in the spring after plowing, and in the fall of 1903 for the crop of 1904. In 1905 the liming was changed to the east half, a ton of quicklime being used that spring, but in 1906 and 1907 ground limestone was used, at the rate of two tons per acre. No lime was applied in 1908. The table gives the average yield for the entire plot in each case, averaging the limed and unlimed halves.

In 1895 and 1896, and again in 1899, 1900 and 1901 the wheat in this test was injured by Hessian fly, the yield on the unfertilized land falling to a small fraction over one bushel per acre in 1896 and 1900.

Diagram II shows the arrangement of plots and plan of fertilizing one of the sections in this experiment, the five sections being arranged and treated exactly alike. Tables III and IV give the yields per acre for 1909 and for the average of the 16 years, and Table V shows the general results by periods.

DIAGRAM II: PLAN OF FERTILIZING IN 5-YEAR ROTATION

PLOTS ONE-TENTH ACRE

Fertilizing materials in pounds per acre

Plot No.	On corn			On oats			On wheat			
	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Dried blood	Nitrate of soda
1	....	....	....	....	....	....	....	....	....	....
2	80	....	....	80	....	....	160	....	....	....
3	....	80	....	....	80	....	....	100	....	....
4	....	....	....	....	....	....	....	....	....	....
5	....	....	160	....	....	160	....	....	50	120
6	80	....	160	80	....	160	160	....	50	120
7	....	....	....	....	....	....	....	....	....	....
8	80	80	....	80	80	....	160	100	....	....
9	....	80	160	....	80	160	....	100	50	120
10	....	....	....	....	....	....	....	....	....	....
11	80	80	160	80	80	160	160	100	50	120
12	80	80	240	80	80	240	160	100	50	200
13	....	....	....	....	....	....	....	....	....	....
14	80	80	160	....	....	....	160	100	50	120
15	....	....	....	....	....	....	160	100	50	120
16	....	....	....	....	....	....	....	....	....	....
17	160	80	80	160	80	80	160	100	25	60
18	Barnyard manure, 8 tons on corn and wheat									
19	....	....	....	....	....	....	....	....	....	
20	Barnyard manure, 4 tons on corn and wheat									
21	Same elements as 17, but nitrogen in oilmeal									
22	....	....	....	....	....	....	....	....	....	....
23	Same elements as 17, but nitrogen in dried blood									
24	Same elements as 17, but nitrogen in sulphate ammonia									
25	....	....	....	....	....	....	....	....	....	....
26	Same elements as 11, but phosphorus in bone meal									
27	Same elements as 11, but phosphorus in dissolved bone black									
28	....	....	....	....	....	....	....	....	....	....
29	Same elements as 11, but phosphorus in basic slag									
30	Same elements as 17, but nitrogen in tankage									

TABLE III: CROPS GROWN IN 5-YEAR ROTATION

Yield and increase per acre, 1909. Total fertilizing elements per acre for one rotation.

Plot No.	Fertilizing element: Nitrogen Lbs.	Fertilizing element: Phosphorus Lbs.	Fertilizing element: Potassium Lbs.	Corn: Grain Bus.	Corn: Stover Lbs.	Oats: Grain Bus.	Oats: Straw Lbs.	Wheat: Grain Bus.	Wheat: Straw Lbs.	Hay: Clover Lbs.	Hay: Timothy Lbs.	Plot No.
Yield per acre												
1	...	...	...	24.07	2,190	35.55	2,043	18.92	1,695	5,326	The timothy crop was a failure in 1909	1
2	...	20	...	27.93	1,870	48.98	2,753	29.92	2,655	5,484		2
3	...	...	108	24.32	2,440	40.31	2,730	25.25	2,575	4,987		3
4	...	...	...	20.32	1,800	35.79	2,265	24.00	2,020	4,312		4
5	76	...	...	26.18	2,110	39.77	2,338	25.54	2,528	4,605		5
6	76	20	...	29.57	1,820	54.46	3,308	34.25	3,785	5,377		6
7	...	...	...	13.46	1,530	33.83	2,348	20.50	1,890	4,315		7
8	...	20	108	31.46	2,040	50.08	2,858	31.13	3,163	5,626		8
9	76	...	108	30.00	2,420	51.57	3,060	24.71	2,708	4,826		9
10	...	...	...	20.78	1,740	34.07	2,230	20.17	2,020	3,333		10
11	76	20	108	38.25	2,680	53.60	3,455	34.17	4,200	6,506		11
12	112	20	108	43.07	2,640	54.61	3,113	31.00	3,950	6,395		12
13	...	...	...	12.25	1,340	33.83	1,808	21.54	2,168	4,791		13
14	50	15	74	29.04	2,080	45.63	2,250	34.58	4,065	6,160		14
15	25	10	41	25.04	2,230	36.17	1,898	32.88	4,008	5,609		15
16	...	...	...	17.64	1,680	33.13	2,050	21.29	1,973	3,546		16
17	38	30	108	45.07	2,800	59.93	3,443	33.13	3,943	5,546		17
18	144	48	112	57.36	3,000	51.10	3,015	33.58	4,185	5,973		18
19	...	...	...	24.07	1,980	33.98	2,043	22.84	2,300	3,671		19
20	72	24	56	43.11	2,620	45.39	2,818	33.21	3,418	4,587		20
21	38	30	108	46.11	2,770	53.20	3,038	32.83	4,010	5,981		21
22	...	...	...	22.18	1,990	36.64	2,228	21.55	2,078	3,307		22
23	38	30	108	40.93	2,450	57.58	3,248	32.13	3,843	5,200		23
24	...	...	...	30.50	2,270	59.61	3,103	32.67	3,850	6,160		24
25	...	...	...	22.25	1,990	35.71	2,048	22.38	2,328	4,044		25
26	76	20	108	33.67	2,670	55.24	3,373	32.79	3,983	5,955		26
27	76	20	108	42.07	2,800	51.41	3,265	32.84	4,280	5,591		27
28	...	...	...	14.18	1,740	47.66	3,255	20.67	2,080	3,288		28
29	76	20	108	29.00	2,560	52.58	3,608	31.67	4,100	5,404		29
30	38	30	108	39.96	2,450	58.44	3,310	30.71	3,458	5,858		30
Average unfertilized yield				19.08	1,798	36.02	2,232	21.38	2,055	3,993		
Increase per acre												
2	...	20	...	5 11	—190	13.35	636	9.32	852	496		2
3	...	...	108	2.75	510	4.60	539	2.94	662	337		3
5	76	...	...	8.15	400	4.63	45	2.71	551	292		5
6	76	20	...	13.82	200	19.98	988	12.58	1,852	1,063		6
8	...	20	108	15.56	440	16.17	549	10.74	1,230	1,638		8
9	76	...	108	11.65	750	17.58	791	4.43	731	1,166		9
11	76	20	108	20.31	1,073	19.61	1,366	13.54	2,131	2,687		11
12	112	20	108	27.97	1,167	20.70	1,164	9.92	1,831	2,290		12
14	50	15	74	14.99	627	12.03	361	13.12	1,962	1,784		14
15	25	10	41	9.20	663	2.81	—71	11.51	1,970	1,648		15
17	38	30	108	25.29	1,020	26.52	1,395	11.32	1,861	1,958		17
18	144	48	112	35.43	1,120	17.40	970	11.26	1,994	2,344		18
20	72	24	56	19.67	637	10.52	713	10.80	1,192	1,037		20
21	38	30	108	23.30	783	17.45	872	10.85	1,858	2,553		21
23	38	30	108	18.73	460	21.25	1,080	10.30	1,682	1,647		23
24	38	30	108	8.27	280	23.59	995	10.57	1,605	2,362		24
26	76	20	108	14.11	763	15.55	923	10.98	1,738	2,163		26
27	76	20	108	25.20	977	7.73	412	11.60	2,117	2,051		27
29	76	20	108	14.82	820	4.92	353	11.00	2,020	2,116		29
30	38	30	108	25.78	710	10.78	55	10.04	1,378	2,570		30

TABLE IV: CROPS GROWN IN 5-YEAR ROTATION

Average annual yield and increase per acre for the 16 years, 1894-1909

Plot No.	Fertilizing Elements			Corn		Oats		Wheat		Hay		Plot No.
	Nitrogen Lbs.	Phosphorus Lbs.	Potassium Lbs.	Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	Grain Bus.	Straw Lbs.	Clover Lbs.	Timothy Lbs.	
Yield per acre												
1	...	...	...	31.24	1,697	32.77	1,359	10.95	1,164	2,069	2,853	1
2	...	20	...	38.70	1,889	40.79	1,654	19.10	1,902	2,629	3,079	2
3	...	...	108	35.46	1,956	35.88	1,469	12.80	1,357	2,367	2,915	3
4	...	...	...	30.65	1,664	31.89	1,335	11.64	1,174	2,109	2,734	4
5	76	...	...	35.69	1,849	35.95	1,472	13.57	1,490	2,419	3,138	5
6	76	20	...	44.94	2,005	47.00	1,938	24.70	2,539	3,168	3,438	6
7	...	...	...	31.05	1,648	31.43	1,302	11.42	1,171	1,997	2,578	7
8	...	20	108	44.25	2,173	43.15	1,813	20.37	1,929	2,944	3,046	8
9	76	...	108	36.26	1,937	37.19	1,586	14.21	1,519	2,375	2,931	9
10	...	...	...	29.47	1,589	31.74	1,293	11.32	1,129	1,935	2,515	10
11	77	20	108	47.80	2,298	50.09	2,236	27.48	2,930	3,365	3,582	11
12	112	20	108	48.36	2,310	49.24	2,285	28.16	2,992	3,469	3,474	12
13	...	...	...	29.84	1,636	31.55	1,332	11.46	1,168	1,979	2,556	13
14	50	15	74	44.82	2,200	39.31	1,688	25.84	2,723	3,005	3,210	14
15	25	10	41	35.15	1,998	32.58	1,338	24.56	2,550	2,580	2,910	15
16	...	...	...	27.96	1,650	29.72	1,222	10.24	1,006	1,772	2,446	16
17	38	30	108	47.03	2,440	48.18	2,208	22.79	2,319	3,094	3 186	17
18	144	48	112	51.11	2,605	39.63	1,822	21.36	2,324	3,822	4,014	18
19	...	...	...	31.81	1,751	30.93	1,301	11.04	1,127	1,912	2,574	19
20	72	24	56	44.03	2,202	37.47	1,639	17.89	1,909	2,936	3,446	20
21	38	30	108	46.79	2,286	47.15	2,131	23.98	2,507	2,875	3,050	21
22	...	...	...	28.56	1,683	30.29	1,258	10.64	1,055	1,653	2,306	22
23	38	30	108	46.53	2,266	47.52	2,086	22.80	2,290	2,787	3,022	23
24	...	...	...	46.61	2,287	48.98	2,276	23.39	2,363	2,964	2,948	24
25	...	...	...	31.37	1,764	31.61	1,358	11.62	1,204	1,941	2,611	25
26	76	20	108	46.08	2,341	47.24	2,058	24.07	2,473	3,483	3,637	26
27	76	20	108	47.84	2,337	49.48	2,232	26.77	2,742	3,086	3,449	27
28	...	...	...	32.99	1,828	33.47	1,392	11.25	1,078	2,014	2,847	28
29	76	20	108	48.06	2,419	47.74	2,112	25.05	2,617	3,231	3,797	29
30	38	30	108	47.22	2,248	44.61	1,929	22.52	2,203	3,247	3,743	30
Average unfertilized yield				30.49	1,691	31.54	1,317	11.17	1,129	1,938	2,602	
Increase per acre												
2	...	20	...	7.66	204	8.31	303	7.92	735	546	266	2
3	...	...	108	4.61	281	3.70	126	1.39	187	271	141	3
5	76	...	...	4.91	190	4.22	148	2.02	318	347	456	5
6	76	...	...	14.02	352	15.42	625	13.20	1,367	1,134	809	6
8	...	20	108	13.73	544	11.62	514	8.98	772	968	490	8
9	76	...	108	6.28	326	5.55	290	2.85	377	419	396	9
11	76	20	108	18.21	693	18.41	930	16.12	1,789	1,415	1,053	11
12	112	20	108	18.64	690	17.62	965	16.75	1,838	1,505	931	12
14	50	15	74	15.61	559	8.37	394	14.78	1,609	1,094	691	14
15	25	10	41	7.87	269	3.32	1[illegible]	13.92	1,490	739	427	15
17	38	30	108	18.23	644	18.05	959	12.29	1,274	1,275	697	17
18	144	48	112	20.97	773	11.16	663	10.59	1,238	1,957	1,482	18
20	72	24	56	13.31	474	6.76	352	6.98	806	1,110	961	20
21	38	30	108	17.14	580	16.60	837	13.21	1,428	1,136	655	21
23	38	30	108	17.04	556	16.79	795	11.83	1,185	1,037	614	23
24	38	30	108	16.18	550	17.81	951	12.09	1,209	1,118	439	24
26	76	20	108	14.17	555	15.02	689	12.58	1,310	1,518	946	26
27	76	20	108	15.39	530	16.63	851	15.40	1,622	1,097	681	27
29	76	20	108	15.07	591	14.27	720	13.80	1,538	1,217	950	29
30	38	30	108	14.23	420	11.15	537	11.26	1,125	1,233	896	30

TABLE V: TOTAL FERTILIZING MATERIALS AND THEIR COST, AND TOTAL AND NET VALUE OF INCREASE PRODUCED FOR 5-YEAR PERIODS AND FOR 16 YEARS, ALL CALCULATED FOR ONE ROTATION OF 5 YEARS

Plot No.	Fertilizing materials in pounds per acre for each rotation	Cost of fertilizers for each rotation	Average value of total increase per acre for each rotation				Net gain or loss (—) from fertilizers for each rotation				Plot No.
			First 5-years	Second 5-years	Third 5-years	16-year average Total	First 5-years	Second 5-years	Third 5-years	16-year average Net	
2	Acid phosphate, 320	$ 2.60	$ 8 50	$17.37	$24 32	$16.48	$ 5.90	$14.77	$21.72	$13.88	2
3	Muriate potash, 260	6.50	5.19	4.67	9.17	6.40	—1.31	—1.83	2.67	—.10	3
5	Nitrate Soda, 440; dried blood, 50	14.40	4.70	10 40	9 03	8 80	—9 70	—4.00	—5 37	—5.60	5
6	Acid phosphate, 320; nitrate soda, 440; dried blood, 50	17.00	19.09	35.27	39.75	31.09	2.09	18.27	22.75	14.09	6
8	Acid phosphate, 320; muriate potash, 260	9.10	14.40	24.37	33.51	24.10	5.30	15 27	24 41	15.00	8
9	Muriate potash, 260; nitrate soda, 440; dried blood, 50	20.90	5.85	11.35	13.23	10.95	—15.05	—9 55	—6 67	—9 95	9
11	Acid phos., 320; mur. potash, 260, nit. soda, 440; dried blood, 50	23.50	26.39	42.43	49.96	39.33	2.80	18 93	26.46	15 83	11
12	Acid phos., 320; mur. potash, 260; nit. soda, 680; dried blood, 50	30.70	26 16	45.53	48 24	39 72	—4 54	14.83	17.54	9.02	12
14	Acid phos., 240; mur. potash, 180; nit. soda, 280; dried blood, 50	16.05	21.37	32.91	37.33	30.56	5.32	15.86	21 28	14 51	14
15	Acid phos., 160; mur. potash, 100; nit. soda, 120; dried blood, 50	8.60	13 89	22 86	27.13	21 91	5.29	14.26	18 53	13.31	15
17	Acid phos., 480; mur. potash, 260; nit. soda, 220; dried blood, 25	17.60	15.74	36.61	46.28	33.63	—1.86	19.01	28.68	16.03	17
18	Yard manure, 16 tons	?	19.82	34.24	55 94	36 91	?	?	?	?	18
20	Yard manure, 8 tons	?	13.02	21.28	35.36	23.09	?	?	?	?	20
21	Same elements as 17, but nitrogen in oilmeal	17.60	20.43	36 25	42 24	32 34	2.83	18.65	24.64	14.74	21
23	Same elements as 17, but nitrogen in dried blood	17.60	19 09	34.37	39.28	30 73	1.49	16 77	21.68	13.13	23
24	Same elements as 17, but nitrogen in sulphate ammonia	17.60	20.70	32.77	38.71	30 69	3.10	14.77	21.11	13.09	24
26	Same elements as 11, but phosphorus in bonemeal	23 50	20.89	36.17	42.55	32.92	—2.61	12 67	19 05	9 42	26
27	Same elements as 11, but phosphorus in dissolved boneblack	23.50	19.86	39 88	42.08	33.84	—3.64	16.38	18.58	10 34	27
29	Same elements as 11, but phosphorus in basic slag	23.50	21.91	39 32	39.04	33.16	—1 59	15 82	15.54	9.66	29
30	Same elements as 17, but nitrogen in tankage	*17.60	13.74	30.51	41.62	28.45	....	12.90	24 02	10.85	30

The nearest practicable approach to a common denominator for the various kinds of produce grown in this rotation is their market value, and in Table V the results of the test are arranged on this basis for three 5-year periods and for the entire 16 years, corn being rated at 40 cents per bushel, oats at 30 cents, wheat at 80 cents, hay at $8.00 per ton, stover at $3.00 and straw at $2.00; valuations much below present prices for the grains, but not far from the average values during the period of the test.

The fertilizing materials are valued at a fraction over $16.00 per ton for acid phosphate, 2½ cents per pound for muriate of potash and 3 cents per pound for nitrate of soda; and it is assumed that the cost per pound of the fertilizing elements will be practically the same in the other carriers used on Plots 21 to 30 inclusive.

The table shows that the effectiveness of the fertilizers and manure has increased with each successive period, the greatest relative increase being shown by the manure. Taking the second part of the table, giving the net gain after deducting the cost of the fertilizers, it will be seen that during the first period eight of the fertilizer applications failed to produce sufficient increase to cover their cost; during the second period three, and during the third period two. Every complete fertilizer has been used with a profit since the first period, but when either nitrate of soda or muriate of potash has been used unaccompanied by some carrier of phosphorus there has been a loss in each period and in the average of the 16 years.

Nevertheless, both nitrogen and potassium are essential to the highest net profit, as shown by comparing Plot 2, receiving phosphorus only, with Plot 8, receiving potassium in addition and Plot 11, receiving these with nitrogen.

The results of the comparison of different carriers of nitrogen and phosphorus have been discussed in Circular No. 93.

*For last 2 periods.

THE POTATOES-WHEAT-CLOVER ROTATION

This experiment is located on the South farm, southeast of the orchards, and contains three sections of 34 plots each. The south section (A) and about half of the middle section (B) had been in cultivation for an unknown period before the test began. The north part of section B and all of the north section (C) were cleared from the forest for the purposes of this test. The old land was tile drained in 1893 and the work was begun by planting Section A to potatoes in 1894. Wheat and clover followed in 1895 and 1896 and the rotation has been maintained regularly since.

The potato crops in this test have in some seasons been somewhat injured by blight, and in 1904 a dashing rain, coming just after the potatoes had been planted, washed much of the seed out of the ground. These difficulties have caused an irregular stand, and for this reason the results have been "corrected" on the basis of the average stand obtained on the unfertilized plots. Both actual and "corrected" yields are given in the table. In 1909 the potatoes were reduced to about one-third the average crop by a combined attack of white grub and Fusarium wilt, the latter causing the larger part of the injury.

In 1895 and 1896 the wheat in this test was severely injured by Hessian fly, but it escaped the attack of 1899 to 1901.

In 1900 the clover failed; attempts were made to grow crimson clover and soybeans in its stead, but there was failure in securing a stand of these crops also, so that it has been necessary to omit that season from the calculations. In 1905 continuous rains prevented harvesting the clover until very late, and caused the fertilized plots to lodge, so that these plots weighed less than those not fertilized, though earlier in the season they had shown a distinctly stronger growth. As there was no way by which the yields could be corrected and as it seemed desirable to include the crop in the general average because of its effect on the average unfertilized yield it has been so included, although the doing so slightly reduces the apparent average effect from the fertilizers.

Diagram III shows the arrangement of plots and plan of fertilizing one of the sections in this experiment, the three sections being arranged and treated alike. Tables VI and VII give the yield per acre for 1909 and for the 16 years, 1894-1909.

DIAGRAM III: PLAN OF FERTILIZING IN POTATOES-WHEAT-CLOVER ROTATION

PLOTS ONE-TENTH ACRE

Fertilizing materials in pounds per acre

Plot No.	On Potatoes			On Wheat			
	Acid Phosphate	Muriate of potash	Nitrate of soda	Acid phos-phate	Muriate of potash	Dried blood	Nitrate of soda
1	....	...	....	....	....	....	..
2	160	....	....	160	....	....	....
3	....	100	....	....	100	....	....
4	....	....	....	....	....	....	....
5	...	....	80	....	....	50	120
6	160	....	80	160	....	50	120
7	....	....	....	....	....	....	....
8	160	100	....	160	100	....	....
9	....	100	80	....	100	50	120
10	.. .	....	....	....	....	....	....
11	160	100	80	160	100	50	120
12	160	100	160	160	100	50	200
13	....	....	....	....	....	....	....
14	320	200	160	160	100	50	120
15	480	300	320	....	....	....	....
16	....	....	....	....	....	....	....
17	....	....	....	Manure, 4 tons			
18	....	....	....	Manure, 8 tons			
19	....	....	....	....	....	....	....
20	160	100	80	160	100	25	60
21	Same elements as 20, but nitrogen in oilmeal						
22	....	....	....	....	...	....	....
23	Same elements as 20, but nitrogen in dried blood						
24	Same elements as 20, but nitrogen in sulphate ammonia						
25	....	....	....	....	....	....	...
26	Same elements as 11, but phosphorus in bone meal						
27	Same elements as 11, but phosphorus in dissolved bone black						
28	....	....	....	....	....	....	....
29	Same elements as 11, but phosphorus in basic slag						
30	Manure, 8 tons						
31	....	....	....	....	....	....	....
32	Manure, 16 tons						
33	Same elements as 20, but nitrogen in tankage						
34	....	....	....	....	....	....	.. .

CROPS IN 3-YEAR ROTATION OF POTATOES, WHEAT AND CLOVER

TABLE VI: Yield per acre 1909, and average for 16 years, 1894-1909

Fertilizing elements for each rotation

Plot No.	Fertilizing elements: Nitrogen Lbs.	Phosphorus Lbs.	Potassium Lbs.	Potatoes: 1909 Bus. (actual)	Potatoes: 16-yr. av. Bus.	Wheat: 1909 Grain Bus.	Wheat: 1909 Straw Lbs.	Wheat: 15-year average Grain Bus.	Wheat: 15-year average Straw Lbs.	Clover: 1909 Lbs.	Clover: 14-yr. av. Lbs.	Plot No.
1	.	...	...	64.32	159.57	34.37	4,137	31.14	3,209	5,564	4,260	1
2	...	20	...	46.83	174.15	40.33	5,140	36.61	3,837	6,193	4,484	2
3	...	...	83	70.77	172.04	39.29	4,422	33.12	3,100	6,791	4,128	3
4	...	...	...	55.39	163.66	40.17	4,270	31.15	3,060	5,724	3,845	4
5	38	..	...	60.78	168.32	41.17	4,370	31.42	3,278	6,658	4,131	5
6	38	. 20	...	61.09	175.14	43.25	5,445	36.88	3,922	7 093	4,286	6
7	...	...	...	33.23	149.72	38.50	3,970	29.08	2,840	4,516	3,781	7
8	...	20	83	94.33	183.16	40.21	3,947	36.34	3,390	5,982	4,064	8
9	38	...	83	89.25	166.63	45.62	4,802	35.20	3,321	5,831	4,277	9
10	...	...	...	40.41	152.81	40.71	4,077	30.32	2,881	4,382	3,647	10
11	38	20	83	86.33	177.97	43.54	5,507	38.94	3,839	6,596	4,159	11
12	50	20	83	92.50	185.10	43.54	5,827	38.72	3,984	7,200	4,377	12
13	...	..	...	31.83	151.14	42.00	4,320	29.69	2,777	4,756	3,787	13
14	50	30	124	110.83	186.45	43.67	6,180	38.64	3,961	6,649	4,322	14
15	50	30	124	100.17	182.34	44.87	5,357	37.33	3,639	6,311	4,303	15
16	...	...	...	34.50	141.34	41.33	3,980	28.16	2,551	4,124	3,531	16
17	36	12	28	64.58	152.39	44.46	4,792	32.20	3,167	5,591	4,146	17
18	72	24	56	61.08	156.36	43.79	4,872	33.26	3,245	6,933	4,544	18
19	...	...	...	46.67	139.46	38.12	3,622	25.37	2,464	3,822	3,257	19
20	25	20	83	88.25	182.45	44.33	5,190	34.65	3,422	5,840	4,097	20
21	25	20	83	74.09	173.81	44.04	4,977	34.78	3,316	4,622	3,689	21
22	...	...	...	49.31	141.97	38.67	3,620	25.07	2,278	3,671	3,323	22
23	25	20	83	83.83	169.97	43.50	5,430	35.46	3,368	5,218	3,759	23
24	25	20	83	88.92	177.11	43.75	4,755	35.44	3,296	5,147	3,747	24
25	...	...	...	45.75	141.18	36.37	3,867	25.51	2,380	3,849	3,361	25
26	38	20	83	90.58	171.11	42.96	4,862	36.13	3,452	6,178	4,122	26
27	38	20	83	88.92	177.10	42.96	5,382	37.35	3,747	5,867	3,919	27
28	...	...	...	56.00	143.58	35.12	3,172	25.57	2,479	4,258	3,499	28
29	38	20	83	99.42	175.79	40.50	4,270	37.80	3,772	6,898	4,405	29
30	72	24	56	104.23	187.67	42.12	4,152	32.53	3,158	5,840	4,305	30
31	...	...	...	39.42	148.87	33.92	3,355	25.42	2,468	4,658	3,410	31
32	144	48	112	113.92	175.96	42.75	5,685	39.10	3,990	7,351	4,196	32
33	25	20	83	78.17	167.20	42.33	4,220	39.02	3,620	5,984	3,356	33
34	...	...	..	39.33	132.74	34.37	3,517	27.49	2,565	4,676	2,877	34
Average unfertilized yield				44.68	147.69	37.80	3,826	27.41	2,628	4,500	3,601	

TABLE VII. Increase per acre, and annual average for 16 years, 1894-1909

Cost of fertilizer for 1 rotation and 16-year average value of increase for each rotation

Plot No.	Potatoes: 1909 Bus. (actual)	Potatoes: 16-yr. av. Bus.	Wheat: 1909 Grain Bus.	Wheat: 1909 Straw Lbs.	Wheat: 15-year average Grain Bus.	Wheat: 15-year average Straw Lbs.	Clover: 1909 Lbs.	Clover: 14-yr. av. Lbs.	Cost of fertilizer	Value of increase for one rotation: Total	Value of increase for one rotation: Net	Plot No
2	—14.51	13.21	4.03	959	5.49	677	579	364	$ 2.60	$11.81	$ 9.21	2
3	12.40	9.70	1.05	196	1.98	—9	1,120	145	5.00	6.03	1.03	3
5	12.78	9.31	1.56	200	.96	292	1,337	308	7.20	6.02	—1.18	5
6	20.47	20.77	4.19	1,375	7.11	1 009	2,174	484	9.80	16.94	7.94	6
8	58.71	32.41	.97	—59	6.85	552	1,511	328	7.60	20.31	12.71	8
9	51.23	14.85	5.65	761	5.29	487	1 404	586	12.20	13.00	.80	9
11	48.78	25.74	2.40	1,349	8.83	1,026	2 089	466	14.80	20.25	5.45	11
12	57.81	33.41	1.97	1,588	8.82	1,189	2,569	637	19.60	24.16	4.56	12
14	78.11	38.55	1.89	1 973	9.46	1 259	2,104	621	21.00	26.73	5.73	14
15	66 56	37.69	3.32	1 264	8.66	1 012	1,976	687	21.00	25.76	4.76	15
17	26.02	15.61	3.87	932	4.97	645	1,568	707	?	13.69	?	17
18	18.47	20.90	3.93	1,131	6.92	752	3 010	1 196	?	19.43	?	18
20	40.70	42.16	6.03	1 569	9.38	1,021	2,068	818	12.40	28.66	16.26	20
21	25.66	32.68	5.55	1,356	9.61	976	901	388	12.40	23.29	10.89	21
23	35.71	28.17	5.60	1,728	10.24	1,056	1,488	423	12.40	22.21	9.81	23
24	41.98	35.66	6.61	970	10.07	950	1,357	398	12.40	24.86	12.46	24
26	41.41	29.13	7.01	1,227	10.60	1,039	2,193	712	14.80	24.02	9.22	26
27	36.34	34.32	7.42	1,978	11.80	1,302	1,745	467	14.80	26.34	11.54	27
29	48.95	30.45	5.78	1,037	12.28	1 297	2,507	935	14.80	27.04	12.24	29
30	59.28	40.56	7.80	858	7.06	686	1,315	866	?	26.02	?	30
32	74.53	45.80	8.68	2 276	10.90	1 295	2,687	1 229	?	33.32	?	32
33	38.81	31.42	8.11	769	11.22	990	1,314	448	12.40	24.33	11.93	33

—Loss

BARNYARD MANURE TEST

COMPARISON OF YARD WITH FRESH MANURE

THE REINFORCEMENT OF MANURE

This experiment was begun in 1897 for the purpose of comparing manure which has lain for some months in an open barnyard with that taken directly from the stable to the field, and of studying the effect of treating the manure with several absorbent or reinforcing materials.

In this investigation a lot of manure has been taken from the open barnyard, where it has been accumulating during the winter, and divided into four parcels. With one parcel is mixed the finely ground, phosphatic rock, known as floats, from which acid phosphate is made by mixing it with sulphuric acid; with another parcel acid phosphate is mixed; with a third, the crude potash salt, known as kainit, and with a fourth, land plaster or gypsum; the reinforcing materials being used at the uniform rate of 40 pounds per ton of manure. At the same time manure taken from box stalls, where it has accumulated under the feet of animals kept continuously in their stalls, is divided into similar parcels and treated with like quantities of the same materials.

After a few weeks the manure thus treated, together with two lots of untreated manure, one taken from the yard and one from the stable, is spread upon clover sod at the rate of eight tons per acre and plowed under for corn, the corn being followed by wheat and clover in a 3-year rotation. During the first three seasons soybeans were grown, because of clover failure, and were plowed under.

Three tracts of land, A, B and C, are included in the test, each crop being grown every season. The arrangement of these tracts and the plan of fertilizing are shown in Diagram IV, and the results are given in Tables VIII and IX.

DIAGRAM IV: ARRANGEMENT OF PLOTS AND PLAN OF FERTILIZING IN EXPERIMENTS WITH MANURE

PLOTS ONE-SIXTEENTH ACRE

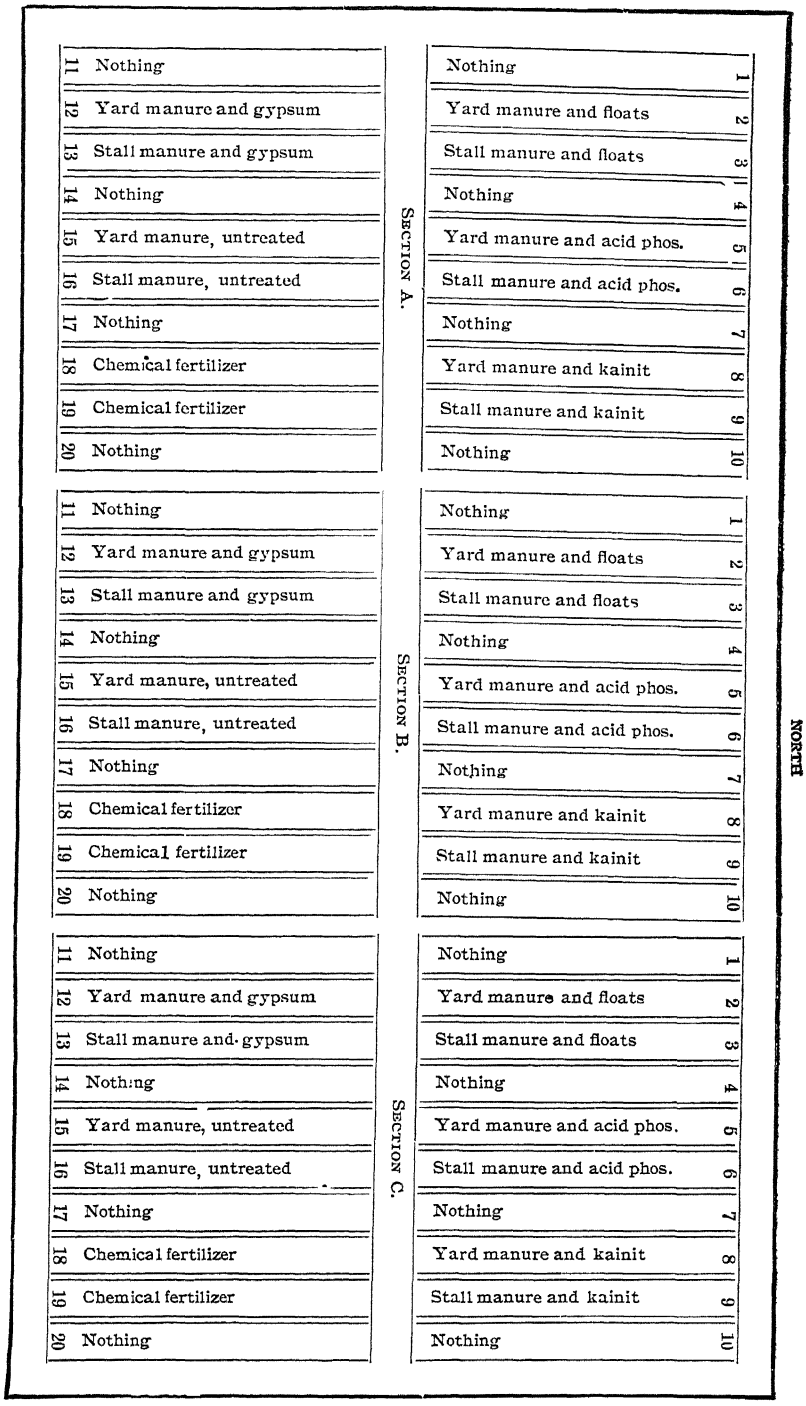


TABLE VIII: BARNYARD MANURE ON CROPS GROWN IN 3-YEAR ROTATION

Average yield per acre 1909 and 13 years 1897-1909

Plot No.	Manure and treatment	1909					13 years, 1897-1909					Plot No.
		Corn		Wheat		Clover	Corn 12 crops		Wheat 12 years		Hay	
		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	Hay Lbs.	Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	9 years Lbs.	
		Yield per acre										
1	None	25.92	2,480	20.27	1,952	6,058	37.15	2,222	12.82	1,517	2,781	1
2	Yard manure and floats	56.48	3.584	32.00	3,136	7,168	59.42	3,313	25.61	2,733	4,167	2
3	Stall manure and floats	65 60	3.616	33.33	3,360	7,794	63.31	3.565	27.00	2,927	4,768	3
4	None	7.84	1,472	21.13	2,092	4,139	31.03	2.009	11.24	1,298	2,049	4
5	Yard manure and acid phosphate	37.28	2,688	36.00	3,584	7,310	60.27	3.276	26.22	2,788	3,962	5
6	Stall manure and acid phosphate	36.48	2,880	33.33	3,376	7,452	64.38	3,471	26.77	2,914	4,687	6
7	None	.96	736	16.80	1,920	4.750	30.83	1.970	10.26	1,220	2,035	7
8	Yard manure and kainit	15.02	1,920	24.13	2,456	6,386	54.63	3,154	21.55	2,399	3,362	8
9	Stall manure and kainit	38.56	2,944	23.07	2,840	6,770	60.07	3,495	23.33	2,712	4,206	9
10	None	17.28	1,920	15.27	1,836	5,006	32.89	2.003	10.71	1,260	2,251	10
11	None	14.80	1,760	22.53	2,360	6,400	36.83	2,333	13.86	1,670	3,016	11
12	Yard manure and gypsum	35.36	3,008	35.20	3,312	6,656	57.98	3,364	24.42	2,700	3,645	12
13	Stall manure and gypsum	42.72	3,328	32.80	3,072	6,656	60.66	3.550	24.07	2,657	3,669	13
14	None	5.31	1,216	20.73	2,084	4,522	31.57	2.007	10.77	1,216	2,012	14
15	Yard manure, untreated	25.76	2.400	31.60	3,000	5,945	51.17	2,886	19.83	2,187	2,927	15
16	Stall manure, untreated	43.68	3,104	32.27	3,088	6,130	58.16	3,304	21.34	2,349	3,587	16
17	None	2.72	1,088	23.60	2,632	4,594	36.55	2,303	11.33	1,355	2,281	17
18	Chemical fertilizer*	28.48	2,336	23.07	2.424	4,608	43.12	2,587	14.23	1,634	2,927	18
19	Chemical fertilizer†	28.64	2.400	21.73	2,632	4,537	44.37	2,456	15.48	1,835	3,046	19
20	None	26.24	2,144	16.07	1,852	4,693	34.09	2 025	10.49	1,299	2,475	20
	Average unmanured yield	12.64	1,602	19.55	2,091	5,020	33.87	2,108	11.41	1,325	2,328	

*Acid phosphate, 80 lbs.; muriate of potash, 80 lbs.; nitrate of soda, 160 lbs.

†Acid phosphate, 80 lbs.; muriate of potash, 10 lbs.; tankage (7-30), 100 lbs.

The corn in this test was injured by insects and bacterial disease in 1909, the injury amounting to an almost complete destruction of the crop on some of the unmanured plots. The manures enabled the corn in some degree to recover from the disaster, and in this respect the fresh manure has in general appeared to be superior to the yard manure, but because of the irregular injury it seems best to omit this crop from the general averages.

TABLE IX: BARNYARD MANURE ON CROPS GROWN IN 3-YEAR ROTATION
Increase over average unmanured yield and its value (excluding corn crop of 1909)

Plot No.	Manure and treatment	Average annual increase per acre					Cost of treatment per acre	Value of increase	
		Corn 12 crops		Wheat 12 crops		Hay			
		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	9 crops Lbs.		Total per acre	Net per ton of manure
2	Yard manure and floats	25 55	1.205	14.20	1,408	1,839	$ 1.40	$32.15	$ 3 84
3	Stall manure and floats	29.44	1,458	15.59	1,602	2,440	1.40	37.80	4.55
5	Yard manure and acid phos	26.40	1,168	14.81	1,463	1,634	2.40	32.16	3 72
6	Stall manure and acid phos	30.51	1.363	15.36	1,589	2,359	2.40	37.56	4.40
8	Yard manure and kainit	20.76	1,046	10.14	1,074	1,034	2.70	23 20	2 56
9	Stall manure and kainit	26.20	1,387	11.92	1,387	1,878	2.70	31.00	3.20
12	Yard manure and gypsum	24.11	1.256	13 01	1,375	1,317	1.00	28.58	3.45
13	Stall manure and gypsum	26.79	1.442	12.66	1,332	1,341	1.00	29.70	3.59
15	Yard manure untreated	17.30	778	8.42	862	599	....	18.08	2.26
16	Stall manure untreated	24.29	1.196	9.93	1,024	1,259	....	25.51	3.19
18	Chemical fertilizer[1]	9.25	471	2.83	309	599	7.45	9.37	....
19	Chemical fertilizer[2]	10.50	348	4.07	510	718	2 30	11 36	....

[1] Acid phosphate, 80 lbs; muriate of potash, 80 lbs; nitrate of soda, 160 lbs.
[2] Acid phosphate, 80 lbs; muriate of potash, 10 lbs; tankage, (7-30) 100 lbs.

In computing the increase in this experiment hitherto the computation has been based on the assumption that the difference in yield between unmanured plots will be progressive. That is, that if the yield of plots 1 and 4 were 30 and 33 bushels, respectively, those of plots 2 and 3 would have been 31 and 32 bushels, had no manure been applied. In general this assumption has been justified in the other experiments of the Station, and so far as sections A and B of this experiment are concerned this is probably the more correct method of computation; but on Section C Plots 1 and 11, which, it will be observed, are continuous, have regularly given yields so much larger than those of the other unmanured plots of this section as to suggest the possibility that the land covered by these plots may have been at one time occupied by a fencerow, the tract lying near a barn, and for this reason it has been deemed best to calculate the increase on the general average of all the unfertilized plots.

By this method of calculation the average increase on Plots 2 and 3 combined is found to be practically the same as that on Plots 5 and 6 combined, but when the larger cost of the acid phosphate is deducted the net gain is a little greater on Plots 2 and 3.

These plots, it will be observed, are receiving about twice as much phosphorus as Plots 5 and 6, but at a lower cost.

The comparison of Plots 18 and 19 is very decidedly in favor of Plot 19, although the expenditure for fertilizer on that Plot is only about one-third that on Plot 18. Plot 19, however, while receiving a smaller total quantity of fertilizer and at a much smaller cost, yet receives more than twice as much phosphorus as Plot 18, and this phosphorus is all in an available form, thus illustrating the hunger of this soil for phosphorus.

LIME AND FLOATS TEST

This experiment was begun in 1905 in a 3-year rotation of corn, oats and clover, for the purpose of comparing the effect of different forms of lime and of obtaining further experience in the use of floats.

The land had been under the regular rotative cropping of the farm since its occupation by the Station, and for a considerable period before, and was in good condition. Twelve tons of manure per acre had been plowed under for corn in 1904. Three sections of 26 plots each are included in the test, the plots containing one-twentieth acre each.

For the crops of 1905 Section A (north end) was manured at the rate of 6 tons per acre only, because of the recent application above mentioned, limed and fertilized and planted in corn. Section B was sown to soybeans instead of clover, the beans to be followed by rye in the fall and corn in 1906. Section C (south end) was limed and fertilized without manure and sown to oats and clover. Thenceforth the manure, lime and fertilizers have all been applied to the corn crops, the manure being plowed under and the lime and fertilizers applied on the surface. The oats and clover receive no treatment.

The clover seeding failed in 1906, 1908 and 1909, and soybeans were sown instead and harvested as hay. As the soybean suffers less from lack of lime than clover the result has been a smaller apparent effect from the lime than might otherwise have been found.

The plan of treatment and average results of the work for the first five years are given in Table X, which includes the data for the clover and oats crops of 1910.

It is evidently too early to attempt to draw conclusions from this experiment. For a soil which is capable of producing a 5-year average of 64 bushels of corn, followed by 50 bushels of oats and 2½ tons of clover hay without any treatment the chief problem is that of maintaining this rate of yield.

So far as present results may be accepted as a guide they support other experiments of the Station in indicating that ground limestone and floats should be used only as reenforcements of manure or fertilizer and never as substitutes.

TABLE X: CROPS GROWN IN 3-YEAR ROTATION UNDER TREATMENT WITH MANURE, LIME AND FLOATS
AVERAGE YIELD AND INCREASE FOR 5 YEARS, 1905-1910

Plot No.	Treatment (Lime, manure, etc., per acre, applied to corn only)	Yield per acre					Increase per acre					Total value of increase	Cost of lime and fertilizer	Net Gain or loss (—) per acre	Gain per ton of manure	Plot No.
		Corn, 5 years		Oats, 5 years		Hay	Corn, 5 years		Oats, 5 years		Hay					
		Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	5 years Lbs.	Grain Bus.	Stover Lbs.	Grain Bus.	Straw Lbs.	5 years Lbs.					
1	None	65.64	3,552	48.16	2,803	5,120	.....	.....	.....	.....	.....	.....	.....	.....	.. ..	1
2	Caustic lime, 500 lbs.; manure, 8 tons	74.31	3,980	50.40	2,923	5,622	9.11	408	3.88	166	449	$ 7.38	$ 1.50	$ 5.88	$ .73	2
3	Caustic lime, 1,000 lbs.; manure, 8 tons	76.19	4,084	54.26	2,988	5,829	11.43	492	3.38	278	620	9.08	3.00	6.08	.76	3
4	None	64.32	3,612	52.24	2,664	5,284	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
5	Caustic lime, 2,000 lbs.; manure, 8 tons	77.51	4,204	55.46	2,977	6,481	12.33	584	3.23	321	1,137	11.65	6.00	5.65	.71	5
6	Ground limestone, 1,780 lbs.; manure, 8 tons	78.47	4,084	55.69	2,922	6,162	12.42	456	3.46	274	757	10.00	2.70	7.30	.91	6
7	None	66.91	3,636	52.23	2,640	5,467	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
8	Air slaked lime, 1,780 lbs.; manure, 8 tons	76.44	4,184	55.19	3,082	6,158	9.70	565	3.87	505	803	9.60	5.30	4.30	.54	8
9	Hydrated lime, 1,320 lbs.; manure, 8 tons	76.42	4,212	54.71	2,981	5,991	9.86	611	4.31	466	748	9.61	4.00	5.61	.70	9
10	None	66.39	3,584	49.49	2,452	5,131	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
11	Gypsum, 1,000 lbs.; manure, 8 tons	71.83	3,948	55.10	2,609	5,108	6.40	417	4.94	180	89	5.23	3.00	2.23	.28	11
12	Floats, 1,000 lbs.; manure, 8 tons	73.22	3,924	55.88	2,668	5,293	8.91	447	5.05	261	385	7.55	4.50	3.05	.38	12
13	None	63.27	3,424	51.49	2,384	4,797	.....	.....	.....	.....	.....	.....	.....	.....	....	13
14	Caustic lime, 1,000 lbs	68.91	3,868	53.40	2,487	5,088	5.97	445	1.79	156	367	5.22	3.00	2.22	.....	14
15	Ground limestone, 1,780 lbs	64.92	3,420	51.13	2,244	4,865	2.31	—1	—.59	—34	219	1.59	2.70	—1.11	.....	15
16	None	62.28	3,420	51.84	2,225	4,571	.....	.....	....	.....	.....	.....	.....	.....	.....	16
17	Caustic lime, 1,000 lbs.; acid phos.; 320 lbs.; mur. potash, 40 lbs.	76.61	4,016	54.52	2,347	5,594	13.23	556	2.67	100	935	10.77	6.60	4.17	.....	17
18	Caustic lime, 1,000 lbs.; floats, 320 lbs.; mur. potash, 40 lbs	74.71	3,980	53.88	2,304	5,575	10.23	480	2.01	34	829	8.76	5.45	3.31	.....	18
19	None	65.58	3,540	51.88	2,292	4,834	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
20	Acid phosphate, 320 lbs	71.68	3,792	50.78	2,195	5,154	6.55	291	—.63	—56	271	3.90	2.60	1.30	.....	20
21	Acid phos., 320 lbs.; mur. of potash, 40 lbs.	75.18	4,060	52.73	2,377	5,396	10.49	597	1.58	167	463	7.58	3.60	3.98	.. ..	21
22	None	64.24	3,424	50.47	2,169	4,982	.....	.....	.....	.....	.....	.....	.....	.....	.....	22
23	Floats, 320 lbs	66.24	3,400	50.71	2,213	4,941	3.11	32	.70	51	81	1.88	1.45	.43	.....	23
24	Floats, 320 lbs.; muriate of potash, 40 lbs.	67.49	3,688	49.49	2,104	4,741	5.46	376	—.06	—52	3	2.69	2.45	.24	.....	24
25	None	60.92	3,256	49.09	2,149	4,616	.....	.....	.....	.....	.....	... .	.....	.....	.....	25
26	Floats, 320 lbs.; mur. of potash, 40 lbs.; dried blood, 100 lbs.*	64.40	3,524	48.72	2,129	4,702	3.48	268	—.37	—20	86	2.00	3.85	—1.85	.....	26
	Average unfertilized yield	64.39	3,434	50.77	2,420	4,977										

*Beginning with 1909 Plot 26 will receive manure only